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Technical Report 61

Standardized Magnitude Estimations of Frequency and Amount for Use in Rating Extensivity

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STANDARDIZED MAGNITUDE ESTIMATIONS OF FREQUENCY AND AMOUNT FOR USE IN RATING EXTENSIVITY

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Introduction

Extensivity in English is a matter of frequency or amount. A limited number of adverbial and adjectival modifiers are available for expressing the range of extensivity in frequency (never to always) and amount (none to all). The extent or degree to which a behavior has been observed, a sensation felt, or an idea experienced can be expressed by one set of modifiers concerning the frequency of occurrence of the observation, sensation or experience. Or their range can be encompassed by another set concerning the amount of the occurrence. Many other aspects of the behavior, sensation, or experience can be described such as their goodness, strength, and potency (Osgood, Suci, & Tannenbaum, 1957). But these can always be expressed in terms of frequency and amount. Thus, a scale evaluating "goodness" can be couched in terms of frequencies of occurrence such as "usually good" or "rarely good" or in terms of amounts of occurrence such as "fairly good" or "very good."

Following Fechner's logarithmic law of the relation between stimulus and sensation, Thurstone (1927) introduced subjective scaling procedures for equal-interval scaling. Quantitative values were assigned to observed behavior, attitudinal statements, sensations, or experiences in the hope of achieving scales of equal intervals with an arbitrary zero. For purposes of merit rating, for instance, this procedure made possible the identification of the scale weights of 724 statements about the performance of any job occupant. These median weights were relatively invariant to the particular sample of judges employed to establish the weights (Uhrbrock,

1950). At about the same time, Hemphill and Coons (undated), in developing the Leader Behavior Description Questionnaire (LBDQ), identified 42 adverbs of frequency or extent. A small group of their staff completed paired comparisons among these against the criterion of how much each expressed frequency or extent. The modal rank reached by each adverb was noted. In any pairing with other adverbs, "always" for example was always judged greater of the pair in how much it expressed frequency or extent. "Never" was always of lesser extent in pairings with other adverbs.

Some years earlier, Simpson (1944) had asked 335 high school and college students to indicate the "number of times in a 100" signified each of 20 adverbs and adverb phrases. They were asked to give a range of estimates for each answer. The midpoint of each respondent's range was tabulated and the median of these midpoints was published as shown in Table 1.

Insert Table 1 about here

Hakel (1958) repeated Simpson's work with 100 Minnesota students. He noted a high degree of agreement between the medians of Simpson's and his samples, as well as large individual differences in response to many of the adverbs. Nevertheless, such individual differences varied considerably from one adverb to the next. For example, the interquartile range found by Hakel for "always" was only 2 (times in 100) varying from Q_1 of 98 to Q_3 of 100. It was only 7 for "frequently," and a remarkably invariant 0 for "about as often as not." For this phrase, Q_1, Q_2, and Q_3 were all 50. All the adverbs implying low frequency such as "seldom," "rarely," and "never" also had low interquartile ranges.

Sheppard (1954) determined for 78 British subjects the mean distance on a 7 inch line represented by the phrases and adverbs, very bad, bad, rather bad, and so forth. Results were as follows:

	Inches	
	Mean	S.D.
Very bad	6.3	.32
Bad	5.5	.44
Rather bad	4.9	.70
Not very bad	3.9	.58
Average	3.4	.29
Not very good	3.4	.57
Rather good	2.3	.47
Good	1.7	.67
Very good	0.8	.27

Much more comprehensively, Cliff (1959) looked at adverbs such as slightly, somewhat, rather, very, etc. as modifiers of a variety of adjectives such as evil, immoral, nice, lovable, etc. Reliability of paired comparison judgments was found to be .999. The multiplying values of "intensity" of each adverb for three college student samples from Wayne, Princeton, and Dartmouth, are shown in Table 2. The stability across the three samples is striking evidence of the relative invariance of such adverb modifiers.

Insert Table 2 about here

Cliff's success with a multiplicative model for adverbs of intensity argues strongly for both the theoretical as well as practical utility of a multiplicative rather than an additive approach to adverbs as modifiers of frequency and amount, such as employed by Hemphill & Coons, Simpson, Sheppard, and Hakel. As a consequence, magnitude estimations using Stevens' procedures (1966) seemed to be a more accurate way of standardizing expressions of frequency and amount, a way which better fitted the true nature of relations between stimulus and subjective experience. Such standardization, if sufficiently invariant for pools of different individuals, could then be used by any investigators desirous of building any kind of behavioral rating scales where objective quantities of frequency and amount could readily be associated with subjective modifiers according to Stevens' law (1971) that equal stimulus ratios produce equal sensations.

Bass (1968) initiated such an effort for a questionnaire survey. The frequency scale he used was based on a magnitude estimation study of 28 adverbs of frequency. Each of 71 undergraduate students had been asked to assign a number of his own choosing to "sometimes," then to indicate what number would best fit each of the 28 other adverbs. On the average, in relation to "sometimes," "always" was seen as 2.533 times as frequent; "very often" was 2.093 times as frequent; "fairly often" was 1.683 times as frequent. Thus, these particular six adverbs of the 28 studied bore an approximate relation to each other of 5:4:3:2:1:0 and were selected as the response alternatives for a questionnaire.

Purpose

The purpose of the present investigation was to obtain reliably established geometric means and standard deviations of magnitude

estimations of reasonably exhaustive lists of expressions of frequency and amount used to modify attitudinal ratings. Also, we set out to see if such results were insensitive to ratings of important, as opposed to unimportant, issues for the raters. It was hypothesized that judges would generate one set of ratios of extensivity when rating issues of consequence to them and a different set when judging issues of little importance to them. Only if the hypothesis was rejected would a single standardized list be possible.

METHOD

The method employed was that of ratio scaling. Ratio scaling uses magnitude estimation (Stevens, 1966, 1971), in which any value is assigned to a referent concept and then all other stimuli are judged in relation to the referent concept. For example, if an individual attaches the value "30" to the word "sometimes" he might assign "15" to the word "seldom" if he felt seldom represented one half as much as sometimes. Likewise he might assign the value "300" to the word "always" if he felt that "always" expressed 10 times as much as the word sometimes.

Subjects

A total of 175 male and female Ss scaled 39 expressions of frequency and 44 expressions of quantity. The expressions appeared in one of five different orders so as to guard against any such order effects. Subjects were drawn from three populations: night school MBA students (most of whom were working), adult undergraduate students, and high school juniors.

Importance Versus Unimportance

The purpose of the present investigation was to scale expressions of frequency (how often) and quantity (how much). Accordingly Ss were randomly assigned to

one of two conditions:

Condition 1: expressions of frequency - important topic
expressions of quantity - unimportant topic

Condition 2: expressions of quantity - important topic
expressions of frequency - unimportant topic

To ensure agreement with what E's considered topics of importance (air pollution and the Viet Nam war) and unimportance (the amount of rainfall in Nepal, worms in the street after a rain storm), we asked Ss to rate each topic on a five-point Likert scale of importance from "extremely important to me" to "extremely unimportant to me." To make more meaningful experimental comparisons, each S's data was analyzed only if a particular topic was ranked either in the top or bottom third of the distribution of importance-unimportance for that topic. Ss who ranked topics in the mid-range of importance-unimportance were deleted from the analysis. This left 134 Ss in the analysis of expressions of frequency (22 MBA students, 37 high school students, and 75 college students) and 130 Ss in the analysis of expressions of quantity (23 MBA students, 34 high school students, and 83 college students).

RESULTS

Results pertinent to the central hypothesis of the study are presented in Tables 3 and 4. These analyses were performed (as suggested by Stevens, 1966, 1971) on the logarithms of the raw data. Table 3 presents the means and standard deviations (antilog values) of the 39 expressions of frequency for the total sample. The multivariate F of 1.55 was not statistically significant, nor were any of the univariate Fs. When the untransformed raw data was analyzed, the multivariate F of 1.79 was statistically significant, as were univariate Fs for the words "rather seldom," "frequently if not

always," "very seldom," and "a great many times." The data was then transformed in two ways. Because different Ss might have chosen different anchor values for the referent concepts (e.g. one S might assign the value 10 to "sometimes" while to another "sometimes" might mean 100) the data was statistically transformed so that each person's anchor value was the same, namely, 50. To do this, each subject's original anchor value was divided into 50 and all other values multiplied by the result. The second transformation involved the use of logarithms of the raw data.

Both transformations yielded identical results. Neither the multivariate F of 1.55 nor any of the univariate Fs was significant when the scale values were compared across important and unimportant contexts.

The log-transformed data were then analyzed by population. Again there were no significant differences in the mean scale values assigned to expressions of frequency when these expressions were imbedded in important, as opposed to unimportant contexts. This conclusion was the same for the MBA's, college students, and high school students that constituted our sample.

In Table 4 are presented the means and standard deviations (antilog values) of the 24 expressions of quantity for the total sample. Neither the multivariate F of 0.84, nor any of the univariate Fs were statistically significant. Again this analysis was performed on the logarithms of the raw data. In contrast to the frequency analysis, neither the multivariate F of 0.94 nor any of the univariate Fs was significant in the analysis of the raw data. In addition, there were no significant differences when the data were transformed so that each S had the same anchor value. The log transformed data were then analyzed by population. Again there were no significant differences across our samples of MBA's, college students, and high school students.

Tables 5 and 6 present, respectively, 4-point through 9-point scales of expressions of frequency and quantity as well as the percentage overlap in distribution between adjacent scale points for the 4-point through 9-point scales of expressions of frequency and quantity. The expressions chosen to represent the various points on each scale are statistically optimal in the sense that their mean scale values came closest to the exact mathematical values necessary to establish a scale of any given ratio, and the observed variances about their respective means were small. The means and standard deviations of all the expressions have been presented in Tables 3 and 4 in the hope that the complete lists can more adequately suit the particular needs of the individual investigator.

Tilton's overlap statistic, 0, (Tilton, 1937) was computed in order to provide an index of the amount of separation present between adjacent scale points. According to Dunnette (1966) values of 0 can be regarded as theoretical values approximating the percentage overlaps to be expected when the same instrument is used in future situations with similarly constituted groups.

It is clear from an examination of Tables 5 and 6 that as scale fineness increases, (that is, as the number of scale points increases) so does the percentage overlap between the distribution of adjacent scale points. As the scale becomes more coarse (fewer scale points) there is correspondingly less overlap between distributions. The greatest decrease in overlap for the frequency scales appears as one moves from the 7-point to the 6-point scale. For the quantity scales this decrease appears as one moves from the 8-point to the 7-point scale. For both types of scales, however, the same relationship holds: the finer the scale, the greater the degree of overlap between the distributions of adjacent scale points.

CONCLUSIONS

We have demonstrated, at least, for three samples of judges at different age, educational, and occupational levels, and for important and unimportant issues, that it is possible to fix the absolute quantitative meanings that are associated with verbal judgments of extensivity. Furthermore, we have been able to identify expressions of amount and frequency that bear integer relations with each other for 4 to 9 point scales. Also we have been able to specify the percent overlap of judgments between adjacent points on a given scale.

What we provide here are a set of invariant positive numbers beginning at zero for summarizing the increases associated with modifying expressions of frequency and amount. One interesting use of the point scales and their numerical equivalents would be to locate the verbal expression most closely matching a mean result which fell between two scale points. For example, suppose the five point scale of frequency (Table 5) had been used in a study of some substantive issue, and the mean result for a group of respondents came to 4.5, halfway between always and very often. Table 3 indicates that the expression continually (50.16) lies just about halfway between always (58.01) and very often (42.45).

The tabled results should be useful to scale developers. Scales using the expressions listed should be more comparable quantitatively. If the judgment "sometimes" is set at 19, the judgment "always" has a reliable numerical equivalent of 58 in people's minds. Many summary operations, obviously, are easier to perform using such numbers, as opposed to the words themselves, particularly if the numbers are in a ratio scale with an absolute zero.

More precision can be obtained for translations. Just how equivalent are the French "toujours", Spanish "siempre" and English "always"? For cross-language contracts, treaties and agreements, the possibility opens of using the universal language of mathematics to locate zones of disagreement between what were purported to be the same statements in different languages.

There are also implications for the use of Likert-type scales. Likert-type scales are extremely popular in industrial as well as consumer research. Such scales are often constructed of varying numbers of scale points, and employ various adjectival and/or adverbial modifiers as anchors for each scale point. Past research has focused on several properties of these scales. Investigations by Bendig (1954) and Komorita (1963) revealed that internal consistency reliability is independent of the number of scale points employed. More recently Matell and Jacoby (1971) replicated these findings and also revealed that stability, predictive validity, and concurrent validity of cumulative scores from Likert-type items were also independent of the number of scale points utilized. Most recently Matell and Jacoby (1972) demonstrated that for cumulative scores from Likert-type items, proportion of scale used was independent of the number of scale points, while mean testing time increased, and usage of the "uncertain" category decreased as the number of rating steps increased. Our work clearly shows one significant effect associated with the number of scale points used, i.e. as the number of points increases, so also the percent overlap in adjacent judgments increases. Perhaps this is another way of saying that when we move from 3 to 8 points, we pay a price for the increase in scale fineness. That is, if we don't demand seven point scales and use four point scales instead, we minimize the possibility of overlap in judgments. If we

provide say 9 points, then the overlap between adjacent point judgments can run as high as 44 per cent.

A word of caution is in order, however, before we indiscriminately abandon nine point (or finer) measuring scales. In some contexts they do have a place. For instance Ebel (1969) demonstrated that from an educational measurement standpoint the use of broad categories in grading is likely to increase the relative amount of error present in the measures on which the grades are based. This is true regardless of the degree of inaccuracy of those measures. The finer the scale used for reporting grades, i.e. the more different grade levels it provides, the more accurate the grade reports will be.

Furthermore, Ebel demonstrated that error is more often increased than diminished when grouping error is added to measurement error and the variance of the combined errors is greater than the variance of the original errors of measurement. Now since the reliability of a set of measures is determined by the relation of error variance to true score variance, the addition of grouping errors to measurement errors increases the overall error variance and therefore reduces the reliability of the scores. In general then, the fewer the categories and the more reliable the original basis for grading, the greater the loss of reliability as a result of broad categories in marking.

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Table 1

Simpson's Median Equivalents
of Adverbs of Frequency

Term	Means this % of the time	Term	Means this % of the time
Always	99	Occasionally	20
Very often	88	Once in a while	15
Usually	85	Not often	13
Often	78	Seldom	10
Generally	78	Usually not	10
Frequently	73	Hardly ever	7
Rather often	65	Very seldom	6
About as often as not	50	Rarely	5
Sometimes	20	Almost never	3
Now and then	20	Never	0

(From Simpson, 1944, p. 328)

Table 2

Extent Adverbs "Intensify" Adjectives Multiplicatively in Three Samples

Adverb	Wayne	Princeton	Dartmouth
(Unmodified)	1.000	1.000	1.000
Slightly	.555	.538	.559
Somewhat	.685	.662	.719
Rather	.846	.843	.887
Pretty	.935	.878	.961
Quite	1.042	1.047	1.109
Decidedly	1.216	1.165	1.231
Unusually	1.291	1.281	1.324
Very	1.317	1.254	1.323
Extremely	1.593	1.446	1.546
N	218	186	133

(From Cliff, 1959, p. 38-39)

Table 3

Means and Standard Deviations of Expressions of Frequency

Expressions of Frequency	Mean	SD
Always	58.01	3.524
Continually	50.16	3.177
Constantly	49.70	3.311
Frequently if not always	45.24	3.062
Very often	42.45	3.076
A great deal of the time	41.37	3.083
Very frequently	40.02	3.327
A great many times	39.28	3.090
Usually	39.18	3.133
Often	37.64	3.090
Frequently	36.07	3.289
Quite often	35.39	3.930
Rather frequently	34.44	3.177
Commonly	32.97	3.140
Fairly often	32.64	3.303
Fairly many times	30.65	3.000
Sometimes	19.42	2.864
Some of the time	18.01	3.013
To some degree	15.52	2.918
Now and then	15.19	3.040
Occasionally	14.92	3.062
Once in a while	10.22	2.890
Not often	7.78	2.553
Not very often	7.23	2.559
Fairly infrequently	6.99	2.722
Infrequently	6.47	2.606
Rather seldom	6.42	2.660
Very seldom	4.72	2.642
Rarely	4.56	2.234
Very infrequently	4.54	2.472
Seldom if ever	3.69	2.421
Hardly at all	3.47	2.383
Hardly ever	3.34	2.234
Very rarely	2.99	2.109
Almost never	2.63	2.104
Seldom	.33	2.600
None of the time	.17	1.485
Not at all	.15	1.525
Never	.08	1.411

Table 4

Means and Standard Deviations of Expressions of Quantity

Expressions of Quantity	Mean	SD
All	66.12	4.315
An exhaustive amount of	59.27	4.710
Almost entirely	57.61	5.755
Completely	57.35	5.900
An extraordinary amount of	54.46	4.375
Almost completely	51.38	4.710
An extremely abundant amount of	48.89	4.519
An extreme amount of	48.20	3.589
A great amount of	41.56	2.741
A great deal of	41.36	2.825
Very much	40.59	2.938
A full amount of	40.50	3.785
A lot of	37.10	2.774
Much	35.14	2.636
Quite a bit of	34.24	2.708
A good bit of	32.65	3.133
A considerable amount of	31.44	2.904
Pretty much	30.04	2.870
Fairly much	27.70	2.423
An ample amount of	26.22	2.812
An adequate amount of	24.07	2.600
A moderate amount of	21.80	3.420
Some	18.63	2.918
To some extent	13.42	2.945
To some degree	13.10	2.717
Somewhat	11.75	3.034
A limited amount of	9.57	2.851
A little	7.81	2.495
A small amount of	7.51	2.524
Comparatively little	7.22	2.710
A little bit of	7.20	2.673
Not much	7.02	2.698
A small degree of	5.27	2.501
Very little	5.21	2.449
A slight amount of	5.09	2.583
A meager amount of	4.28	2.660
A scanty amount of	3.68	2.410
A minimum amount of	3.64	2.707
A trifling amount of	3.13	2.594
Scarcely any	2.98	2.198
A trivial amount of	2.85	2.600
An insignificant amount of	2.48	2.108
Hardly any	2.28	2.204
None	.15	1.653

Table 5

Statistically Optimal Scales of Frequency and Percentage Overlap between Scale Points

Number of Points in Scale

Nine	Eight	Seven	Six	Five	Four
8 Always	7 Always	6 Always	5 Always	4 Always	3 Always
24%	24%	24%	5%	2%	<1%
7 Continually	6 Continually	5 Constantly	4 Frequently, if not always	3 Very often	2 Often
21%	21%	4%	8%	12%	<1%
6 Very often	5 Very often	4 Often	3 Quite often	2 Fairly many times	1 Sometimes
24%	13%	25%	1%	<1%	<1%
5 Quite often	4 Rather frequently	3 Fairly many times	2 Sometimes	1 Occasionally	0 Never
42%	2.5%	6%	10%	<1%	
4 Fairly many times	3 Sometimes	2 Sometimes	1 Once in a while	0 Never	
6%	45%	10%	2%		
3 Sometimes	2 Now and then	1 Once in a while	0 Never		
45%	16%	2%			
2 Occasionally	1 Not often	0 Never			
16%	7%				
1 Not very often	0 Never				
7%					
0 Never					

*Represents the percentage overlap in distributions between its own scale point and the scale point directly below it. Thus, there is 24% overlap in response distributions between response at point 7 and response at point 8 in the nine-point scale.

Table 6

Statistically Optimal Scales of Quantity
and Percentage Overlap between Scale Points

Number of Points in Scale

Nine	Eight	Seven	Six	Five	Four
8 All	7 All	6 All	5 All	4 All	3 All
44%*	39%	18%	10%	2%	<1%
7 An exhaustive amount of	6 Almost entirely	5 An extraordinary amount of	4 Almost completely	3 An extreme amount of	2 A great amount of
18%	31%	7%	16%	3%	<1%
6 An extreme amount of	5 An extreme amount of	4 A great amount of	3 Very much	2 Quite a bit of	1 A moderate amount of
29%	8%	17%	2%	<1%	<1%
5 A great deal of	4 A lot of	3 Quite a bit of	2 Fairly much	1 Some	0 None
20%	7%	5%	<1%	<1%	
4 Quite a bit of	3 Fairly much	2 A moderate amount of	1 To some degree	0 None	
5%	9%	12%	<1%		
3 An adequate amount of	2 Some	1 Somewhat	0 None		
32%	9%	2%			
2 Some	1 A limited amount of	0 None			
5%	4%				
1 A little	0 None				
6%					
0 None					

*Represents the percentage overlap in distributions between its own scale point and the scale point directly below it. Thus, there is 44% overlap in response distributions between response at point 7 and response at point 8.

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